DESIGN OF AIR CONDITIONING SYSTEM FOR AUDITORIUM

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Abstract-Heating, Ventilating and Air Conditioning Systems (HVAC) are applied for primarily cooling purpose as well as to maintain quality of air. The continuous increase of energy consumption around the world requires sustainable solutions for future energy systems. With growing energy consumption, the threats of global warming of the atmosphere increases. Recently, environmental protection agencies around the world have developed novel energy savingschemes and codes to be implemented in industry.

Besides to air conditioning there are ventilation systems like ceiling fan, fresh air supply and exhaust fan where ceiling fan is used to ventilate the air with rotating blades and exhaust fan is used to displace the inside air to outside environment, fresh air supply is used to displace the inside air to the outside environment by supplying fresh air from the outside air.

The ventilation system works on the principles of vapour compression cycles. Our goal is Design of Air Conditioning System for Auditorium and to determine the air flow rate & refrigeration flow rate in the auditorium. First the temperature difference between the inlet and outlet air from the auditorium is determined. Then the heat energy is calculated. And the amount of heat in refrigerant is also calculated by heat energy equation. Calculating of mass air flow rate refrigerant flow rate of the air conditioning system for auditorium.

***KeyWords*:**Heating, ventilating, and air conditioning (HVAC), Vapour compression cycle, refrigerant, heat exchanger.

1.INTRODUCTION

HVAC stands for heating, ventilation, and air conditioning. This system provides heating and cooling to residential and commercial buildings. Becoming more and more popular in new construction. HVAC system works on principal of thermodynamics, fluid mechanics and heat transfer HVAC system are basically an assembly of various types of equipment installed together to provide heating and cooling along with indoor climate control. HVAC systems involve mechanical, electrical and I & C components to provide comfort to the occupants of building/space or to preserve goods, products or items placed in space

Ventilation: Ventilation is the process of changing or replacing air in any space to control temperature or remove any combination of moisture, odors, smoke, heat, dust, airborne bacteria, or carbon dioxide, and to replenish oxygen. Ventilation often refers to the intentional delivery of the outside air to the building indoor space. It is one of the most important factors for maintaining acceptable indoor air quality in buildings. Methods for ventilating a building may be divided into mechanical/forced and natural types.

Air conditioning: An air conditioning system, or a standalone air conditioner, provides cooling or humidity control for all or part of a building. Air-conditioned buildings often have sealed windows, because open windows would work against the system intended to maintain constant indoor air conditions. Outside, fresh air is generally drawn into the system by a vent into a mix air chamber for mixing with the space return air. Then the mixture air enters an indoor or outdoor heat exchanger section where the air is to be cooled down, then be guided to the space creating positive air pressure. The percentage of return air made up of fresh air can usually be manipulated by adjusting the opening dof this vent. Typical fresh air intake is about 10% of the total supply air.

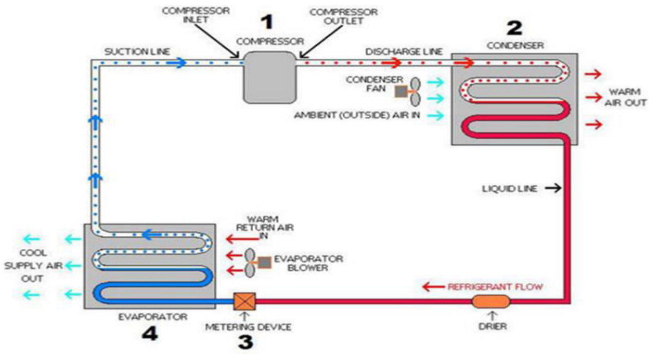

Fig -1: **Refrigeration Cycle**

2.Refrigerant R410 A:

R-410A, sold under the trademarked names AZ-20, Eco Fluor R410, Forane 410A, Genetron R410A, Puron, and Suva 410A, is azeotropic but near-azeotropic mixture of difluoromethane (CH_2F_2, called R-32) and pentafluoro ethane (CHF_2CF_3, called R-125) that is used as a refrigerant in air conditioning applications. R-410A cylinders are coloured rose.

Trade names

- Suva 410A (DuPont)
- Puron (Carrier)
- Genetron AZ-20 (Honeywell)

Property	Value
Formula	CH_2F_2 (50%) CHF_2CF_3 (50%)
Molecular weight (Da)	72.6
Melting point (°C)	−155
Boiling point (°C)	-48.5
Liquid density (30 °C), kg/m^3	1040
Vapour density (30 °C), air=1.0	3.0
Vapour pressure at 21.1 °C (MPa)	1.383
Critical temperature (°C)	72.8
Critical pressure, MPa	4.90
Gas heat capacity (kJ/(kg·°C))	0.84
Liquid heat capacity @ 1 atm, 30 °C, (kJ/(kg·°C))	1.8

Table -1: Physical properties of R-410A Refrigerant

R-410A use is expanding globally and rapidly. While there is some speculation regarding its retirement, there were no generally accepted alternatives for use in commercial air conditioning systems—especially when flammability dis considered—though many companies were researching options.

Types of Air ConditioningSystems

1) Window AirConditioner.
2) Split AirConditioner.
3) Packaged AirConditioner.
4) Central Air ConditioningSystem.

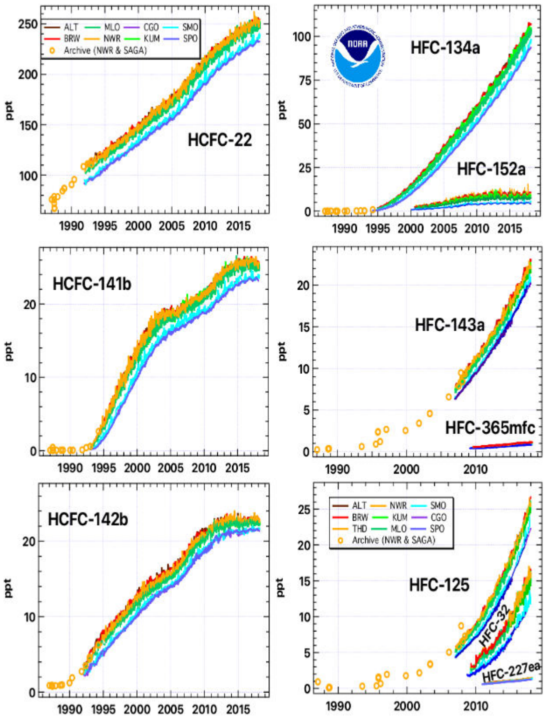

Fig -2: Rapid growth of R410-A

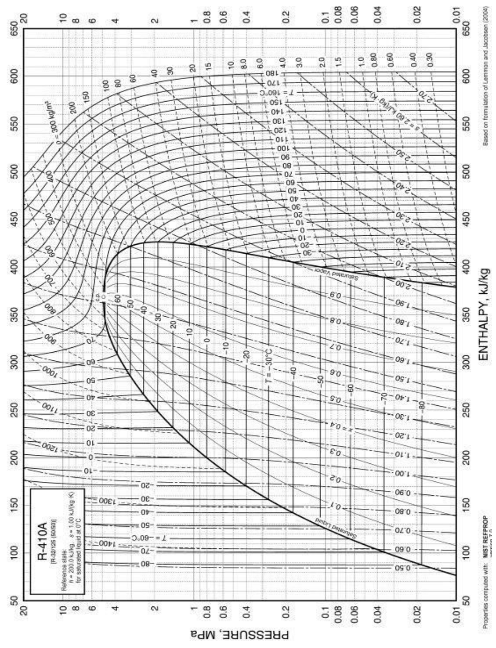

Fig-3: Pressure Enthalpy drop for refrigerant 410-A

3. Calculations:

Air Conditioning System for auditorium.

- Regular buildings have floor to ceiling height of 9 ft to 10 Ft
- Volume of air inside the room is based on height. But in case of auditorium height may be 30 Ft from floor level or 10 metres from the floor level.

Net volume of air inside AC space is much higher.

In auditorium large number of people gathers at same place. Because of this, more heat dissipated by people.

how much air flow rate is required is to be estimated using the formula below?

$$Q = m^* Cp^*\Delta T$$

- ❖ ΔT - refers change in temperature of air before entering heat exchanger and after leaving heat exchanger. In this case, assume it to be 20 K difference.

Once, air flow rate is done, this heat is carried by the refrigerant to the atmospheric air side, and thus we need to find the mass flow rate of refrigerant required to flow within the tubes of heat exchanger.

$$Q = m_r {}^*Cp^*\Delta T$$

- ❖ ΔT - Refers temperature change in refrigerant before entering and after leaving heatexchanger.

1.Air flow rate

Volume of air present in the auditorium =

Length * Width * Height = 25* 20 * 10 = 600 m^3 (Values are assumed)

Assume, 6 KW for every 10 Sq. Mtr floor area.

Net floor area available = 50 Sq. Mtr

Heat load = Q = 300 KW

Ideally, heat load has to be estimated from the walls, roof, floor, windows and doors,

internal loads due to lighting fixtures, electrical equipment, people and air entering the space in the ventilation process.

Total of the above parameters is assumed to be 300 KW of heat energy in the air which needs to be removed by the air conditioning system.

- ❖ Quantity of air flow rate from the auditorium space to the heat exchanger we use to condition the air is: Substituting the values,
  - ➢ $300 = m_a * 1.006 * 20$

$m_a = 14.91$ Kg/s

Volumetric flow rate of air = density / mass

= 1.2047 / 14.91

= 0.08 m^3/s air flow rate through the heat exchanger.

1. Refrigerant flow rate:

Selected Refrigerant: R 410A
Boiling point at atmospheric pressure = -51.44 C = 221.71 K

This is the temperature of refrigerant entering the heat exchanger coil.

The coil is designed so that the heat exchange between the refrigerant and the air happens until they reach equilibrium temperatures.

Assume Refrigerant chose is R410 A;

Cp = 1.001 KJ/Kg K

Thus, the temperature of the refrigerant leaving the coil,

= 20 C = 293.15 K

- ➢ $300 = m_r*1.001*(293.15-221.71)$

Mass flow rate of refrigerant,

$M_r= 4.19$ Kg/s

4.RESULTS AND DISCUSSION

Volume of air in the auditorium = 600m^3
Net heat load = 600KW
Total air flow rate through the heat exchanger = 0.08m^3/s
Total refrigerant flow rate = 4.19m^3/s
Temperature of air before entering heat exchanger and after leaving heat exchanger
= 20˚k
Temperature of refrigerant leaving the coil = 295 ˚k
Mass of air in =14.91 kg/s
Mass flow rate of refrigerant in AC unit = 4.91kg/s

We have designed the schematic diagram of air conditioning system for auditorium and calculated the net heat load produced in auditorium. Specific heat formula is used for calculating the mass flow rate of air and mass flow rate of refrigerant in AC units.

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